APPLICATION FOR
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FOR

ARMORED ASSEMBLY

BY:

DARDO BONAPARTE LUJÁN

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ARMORED ASSEMBLY

BACKGROUND OF THE INVENTION

1. Field of the Invention.

The present invention relates to the field of armors and more particularly to a light ballistic panel and armored assembly including the panel, for absorbing energy such as temperature, sound, impact and shock energy, preferably impact energy from ballistic projectiles, the ballistic panel and assembly being capable of forming protective panels or packs for use in armoring vehicles, buildings, and the like and/or for use in manufacturing ballistic jackets for individuals, wherein the armored assembly comprises a combination of panels for absorbing the energy of projectiles and retaining the projectiles trapped into one or more microfiber made panels.

While specific reference will be made in this specification to the application of the inventive assembly in the ballistic field, this structure may be well applied to other fields where a subject or space must be isolated or protected of undesired impinging energy.

For the purpose of this description, the term projectile or bullet must be understand as one or more bullets per se as well as splinters, pieces and fragments

of bombs, explosives and the like. Ballistic panel and front panel may be used indistinctly because the ballistic panel is generally used, but not necessarily, at a front side of any ballistic or armor assembly.

2. Description of the Prior Art.

It is well known to provide synthetic fibers or threads like aramids for manufacturing ballistic jackets or armored panels for armoring cars, for example. The concept employed for manufacturing these armored products were based in providing combined woven materials and resin materials strong enough, and having a high resistance, to form a solid "wall" against a projectile in order to stop the projectile against the wall generally formed by a compact panel. In these armors the projectile generally impinges against the solid materials and results deformed and stopped against this wall. To stop a bullet, however, these panels must be compact and dense with a high number of layers and material thus having excessive weight that causes these armored or ballistic jackets and panels to be uncomfortable for personal use and no cost effective for use in cars.

In connection to such armor assemblies providing solid walls to stop a bullet, U.S. Patent No. 5,824,940 to Chediak et al. discloses a bullet-proof fabric including a plurality of solid rigid ceramic pieces with the purpose of forming a barrier against a bullet, wherein the pieces are

connected by high strength threads, epoxy adhesives, rivets, an the like, with the purpose of keeping the pieces forming a resistant structure to stop the bullet. Other armor systems consisting of a plurality of rigid solid pieces that are broken when attempting to stop a bullet are those disclosed in U.S. Patents Nos. 5,515,541 to Sacks et al. and 6,510,777 to Neal.

Other jackets and panels employ synthetic fibers forming a mat or a plurality of mats and webs or fabrics. These webs and fabrics are woven with threads forming warps and wefts thus leaving a lot of free spaces, interstices and voids, particularly in the weft-warp crossings and, while a plurality of layers of these webs are employed to manufacture a panel or jacket, any impinging object, particularly a bullet having a sharp tip, may pierce and run through the interstices in the multi layer pack.

Both, the solid or multi layer packs, panels or jackets, do not address the penetration problem by trying to form a kind of "spider web" to receive the projectile and retain the same into the web. The several ballistic packs neither took advantage of the rotation that a projectile is provided of when shoot from a corresponding weapon. This rotation could be used for facilitating the trapping of the bullet into the pack.

This rotation effect has been taken into account by the applicant of the present invention and disclosed in his

U.S. Patent Application Serial No. 10/265,851 relating to a process and apparatus for manufacturing a microfiber structure for absorbing impact energy, sound energy and/or temperature, the structure being preferably used in the ballistic field, wherein the method comprises providing a plurality of threads consisting of microfibers, subjecting the threads to a pressurized air jet to open the threads by separating the microfibers into each thread, and entangling the threads to form a mass of loosely-entangled microfibers, with the mass being confined into a pack which may be appropriately compacted for absorbing impact energy, preferably from a bullet or projectile provided with rotating movement. This structure is formed into a fiber-entangled structure, with the fibers forming preferably curls or loops, thus taking advantage of the rotation of the bullet to cause the bullet be wrapped by the fibers or curls when penetrating the structure. When wrapped by the fibers the bullet increases its mass and size and hence it is prevented from passing through the structure.

The inventor has developed an improved armored assembly comprising a front panel that includes a plurality of side-by-side arranged ring members capable of being penetrated by a bullet and trapped around the bullet in order to increase the size and enlarge the shape of the bullet which, after passing through the front panel, is

easily stopped in a further adjacent trapping panel formed by an entangled mass of fibers.

While the above structures disclosed in the U.S. Patent Applications Serial Nos. 10/265,851 and 10/361,415 have shown to work efficiently in trapping a bullet or any other kind of projectile, the inventor has found that such structures can be improved by providing a front panel that improves and enhances the effect of increasing the size and the shape of the impinging projectile in order to be more easily trapped in a trapping panel.

SUMMARY OF THE INVENTION

It is therefore one object of the present invention to provide an armored structure comprising the combination of a plurality of panels wherein the panels comprise a plurality of entangled-fibers panels working like the ones disclosed in U.S. Patent Application Serial No. 10/265,851, to the same applicant, and at least one front panel comprising ring members capable of being partially penetrated by any impinging projectile in a manner that the projectile enters at least one of the ring members and the ring member or members penetrated by the bullet remain affixed to the bullet thus increasing the mass and size of the bullet or projectile for improving the wrapping effect of the fibers around the projectile.

It is still another object of the present invention to provide a ballistic armor comprising a plurality of sandwiched panels, with a front panel defining an outside surface for receiving the impact of projectiles, the front panel including a plurality of side-by-side arranged ring members, and at least one projectile-trapping panel including a mass of loosely-entangled microfibers, the panels being attached to each other to form a ballistic resistant pack for use in the protection of vehicles, buildings and/or for manufacturing ballistic jackets.

It is even another object of the present invention to provide a ballistic armored assembly for providing protection against ballistic projectiles having an outer maximum dimension, the assembly comprising:

i. at least one front panel including a plurality of side-by-side arranged ring members, each ring member defining an inner diameter smaller than the outer maximum dimension of the ballistic projectile, and

ii. at least one projectile-trapping panel comprised of a mass of loosely-entangled microfibers.

It is even another object of the present invention to provide a ballistic panel for providing ballistic protection, the panel comprising a plurality of deformable pieces that are arranged side-by-side and detachably retained into the panel in a manner that a piece impinged by a projectile becomes attached to the projectile and

removed from the panel, whereby the size and shape of the projectile is increased by the attachment of the piece in order to be more easily stopped by any further panel provided for stopping the projectile, with the panel comprising one or more layers of the following layers:

a). a layer including a plurality of said pieces wherein the plurality of pieces is a plurality of compact ballistic units that are arranged into a side-by-side pattern and compacted into a dense panel, wherein each ballistic unit comprises a plurality of fibers arranged into a bundle that is folded and entangled into a compact mass of fibers, such as a knot;

b). a layer including a plurality of said pieces wherein the plurality of pieces is part of at least one sheet of any deformable material such as metal, high resistance plastics and preferably high-tensile strength fabric cut into said pieces and, when more than one sheet or fabric is employed, the plurality of fabric sheets arranged into a pattern that the pieces of a fabric sheet are offset relative the pieces of any adjacent fabric sheet; and

c). a layer including a plurality of said pieces wherein the plurality of pieces is a plurality of side-by-side arranged ring members, each ring member defining an inner diameter smaller than an outer maximum dimension of the projectile.

It is still another object of the present invention to provide a ballistic armored assembly for providing ballistic protection, the assembly comprising:

i. at least one ballistic panel comprising a plurality of side-by-side deformable pieces that are detachably retained into the panel in a manner that a piece impinged by a projectile is removed from the panel and attached to the projectile, whereby the size and shape of the projectile is increased by the attachment of the piece; and

ii. at least one projectile-trapping panel comprised of a compacted mass of loosely-entangled fibers, whereby the projectile having said increased size and shape is more easily stopped by the projectile-trapping panel.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention is illustrated by way of example in the following drawings wherein:

FIG. 1 shows an exploded perspective, diagrammatical view of a plurality of panels forming and armored assembly according to a preferred embodiment of the invention;

FIG. 2 shows an elevation, cross-sectional view of an armored assembly, with all the panels attached into a pack, according to another embodiment of the invention;

FIG. 3 shows a perspective diagrammatical partial view of a ring member arrangement for an ballistic panel according to an embodiment of the present invention;

FIG. 4 shows a front diagrammatical partial view of a ring member arrangement for the ballistic panel, according to another embodiment of the invention;

FIG. 5 shows a front diagrammatical partial view of a ring member arrangement in a support plate for the ballistic panel, according to another embodiment of the invention;

FIG. 6 shows a front diagrammatical partial view of a ring member arrangement for the ballistic panel, according to another embodiment of the invention;

FIG. 7 shows a cross sectional view of a front panel according to another embodiment of the invention;

FIG. 8 shows a cross sectional view of a front panel according to another embodiment of the invention;

FIG. 9 shows a perspective exploded view of the inventive assembly illustrating the behavior of a bullet impinging on the front panel, passing through this panel and carrying a ring member, thus increasing the size and impinging surface of the bullet, which bullet is entangled in the fibers of a first trapping panel in a manner that the fibers are elongated with the bullet thus increasing its size in a more extent up to impacting the a further

following trapping panel wherein the bullet is finally trapped;

FIG. 10 shows a perspective diagrammatical view of a ring member for the front panel, according to another embodiment of the invention, wherein the ring member is of the spring-type for receiving and blocking the piercing tip of the bullet;

FIG. 11 shows a front diagrammatical partial view of a three-plane ring member arrangement for the front panel, according to another embodiment of the invention;

FIG. 12 shows a partially cross-sectional, perspective diagrammatical view of a ballistic panel according to another embodiment of the invention;

FIG. 13 shows a cross sectional view of panel of FIG. 12, illustrating the behavior of a bullet impinging on the front or ballistic panel, passing through the panel and carrying a ballistic unit made of compacted fibers, like a knot, thus increasing the size, shape and impinging surface and/or profile of the bullet;

FIG. 14 shows a perspective view of a ballistic unit consisting of a compact bundle of fibers which may be obtained by compressing the fibers or treating the bundle under vacuum;

FIG. 15 shows a partially cross-sectional, perspective diagrammatical view of a ballistic panel according to another embodiment of the invention; and

FIG. 16 shows a cross sectional view of panel of FIG. 15, illustrating a bullet impinging the panel and carrying a piece of the sheet, either metal, fabric, etc. to increase the size, shape and impinging surface and/or profile of the projectile or bullet;

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Now referring in detail to the drawings it may be seen from FIG. 1 a preferred arrangement of panels to form a ballistic resistant assembly or pack. The panels are shown in exploded view to clearly appreciate the construction thereof. The ballistic assembly is indicated by general reference 1 and it forms a pack having a front side or outside surface 2 and a rear side or inside surface 3. Surface 2 is designed to face the zone from which the projectiles can be expected to come and surface 3 is the side to face the object, room or individual to be protected against the projectile. The panels are arranged in a "sandwiched" pattern as shown in FIG. 1, comprising at least one basic structure A formed by a front panel 4, preferably a ballistic panel, and at least one projectile-trapping panel 5. While the inventive assembly may be manufactured and may effectively operate with this basic structure A only, FIG. 1 shows another similar basic structure B, like the arrangement of structure A, formed by at least one front panel 4 and at least one projectile-

trapping panel 5. Thus, the basic structure may be repeated to form a multiple layer ballistic assembly.

Preferably, as shown in cross-section in FIG. 2, the assembly comprises a front panel 4, two or three panels 5, another panel 4 and two or three panels 5. Alternatively, the assembly may comprise the above mentioned panels, FIG. 2, or may additionally include, at the inside surface, at least one impact cushioning panel 6, see FIG. 1, such as an EVA panel, a resistant cloth, etc., which may be made of any convenient material such as of polymeric threads selected from the group comprising aramid threads, polyester threads, synthetic threads, Kevlar® (aramid fibers), Twaron® (aramid fibers), Dyneema® (ultra high resistance polyethylene fibers), Roving® (thread fibers), carbon and/or mixtures thereof.

Preferably, all the panels are attached to each other forming a pack and the attachment may be carried out by any convenient means such as adhesives, sewing, etc. These attached panels form a ballistic armor assembly for providing protection against ballistic projectiles wherein the projectile may be a bullet or any fragment from explosives. In any event, the projectile will have an outer maximum dimension and, if it is a bullet, a tip with a minimum dimension.

According to a preferred embodiment, the inventive ballistic panel, preferably employed as a front panel,

comprises a plurality of deformable pieces that are arranged in at least one plane, preferably side-by-side, and detachably retained into the panel in a manner that a piece impinged by a projectile becomes attached to the projectile and removed from the panel, whereby the size and shape of the bullet or projectile is increased by the attachment of the piece in order to be more easily stopped by any further panel provided for stopping the projectile. More specifically, the pieces of the ballistic or front panel comprise a plurality of side-by-side arranged ring members 7, shown in generic views in FIGS. 1 and 2. The ring members provide an increasing of the size, volume, shape and/or impact surface of the bullet, taking profit of its temperature and rotation. The main object of panel 4 is not to stop the bullet but to alter the size, shape and general characteristics of the bullet by attaching at least one removable piece, such as a ring, to the bullet in order to bar the movement thereof through the subsequent remaining panels in the pack or assembly. Each ring member defines an inner diameter that is smaller than the outer maximum dimension of the ballistic projectile, however, for the event that the projectile member is provided with a tip having a minor dimension, a piercing tip for example, the inner diameter of the ring member is larger than the minor dimension of the projectile member. Thus, the inner diameter of the ring member is larger than the tip diameter

of a projectile to permit the projectile to enter the ring member up to an extent that the projectile is wedged or locked into the ring member due to the fact that the outer maximum diameter of the projectile is larger than the inner diameter of the ring member. Consequently, the ring member, when penetrated by a bullet, is carried by the projectile, remaining firmly affixed to the projectile, thus increasing the size, volume, shape and/or mass of the projectile.

According to several embodiments of the invention, the front panels may have their ring members arranged in different convenient manners. For example, ring members may be lock washers, tooth washers, spring washers, rings, spring threads and mixtures thereof. Ring members may be also made of any convenient material such as synthetic material, plastics, composites, resins, metals, etc.

Ring members may be loosely arranged side-by-side in at least one plane or in more than one plane and the ring members may be also interconnected to each other. In this event, the connection should be strong enough to keep the ring members arranged as desired during use but the connection must be capable of being broken upon the impact and penetration of an impinging projectile into a ring member. Thus, if a projectile penetrates a ring member this ring member will be detached from the adjacent ring members and will be carried onto the projectile without altering the remaining structure of the front panel and the

assembly. This concept is valid for any of the inventive removable pieces, preferably deformable pieces that are part of the inventive panel and assembly.

FIG. 3 shows a partial view of a preferred arrangement of ring members, generally indicated by reference 7, formed by spring washers individually indicated by reference 8.

FIG. 4 shows a partial view of another arrangement of ring members, generally indicated by reference 7, formed by conventional rings individually indicated by reference 9.

As shown in FIG. 5, ring members 7 may be arranged side-by-side in a ring member support plate 10 made of any appropriate material such as cardboard, rubber, polymers, plastics, EVA, composites, etc. In this embodiment rings 7 are shown interconnected through connections 11 which are breakable as explained above. The connections are between the rings and/or the support plate.

FIG. 6 shows a partial view of ring members, generally indicated by reference 7, formed by rings individually indicated by reference 12 arranged in a first plane, and rings individually indicated by reference 13 which are offset, that is out of center or alignment, of the ring members of the first plane and arranged at another plane adjacent to the first mentioned plane. When the pieces are in more than one plane or layer, such as the

rings in this FIGURE, it may be not necessary that the pieces are side-by-side arranged.

The arrangement of FIG. 6 may be further improved, as shown in FIG. 11, by placing a third ring-plane comprising ring members 19. Only four ring members have been illustrated for clarity purposes and the third plane rings are off-set of the ones in the first and second planes, as shown in this FIGURE to prevent any bullet to enter in any interstice that may be formed between rings 12 and 13.

The aim of the arrangements of FIGS. 6 and 11 is to avoid the presence of interstices between the rings which interstices would be penetrated by a bullet without a ring being affixed to and carried by the bullet. Thus, with the rings arranged as shown in FIGS. 6, 11, a projectile, even if passing through an interstice between the rings of the first plane will penetrate a ring of the second plane located behind the first plane or a ring 19 of the third plane placed in front of the first plane. This arrangement may be employed with any of the ring members disclosed in this specification, either loosely arranged or interconnected to each other in the same plane or between planes.

According to another alternative embodiment of the invention, the pieces of the invention, such as the illustrated rings, may be embedded into a support plate

made of any plastic or polymeric material, EVA, for example, indicated by reference 14 in FIGS. 7 and 8. Fig. 7 shows rings 7 in only one plane and FIG. 8 shows the rings 12, 13 arranged as shown in FIG. 6, embedded into the support plate, also indicated by reference 14.

As to the projectile-trapping panels 5, the same may be manufactured under the teachings of U.S. Serial No. 10/265,851 and may comprise a mass of loosely-entangled microfibers 15, FIGS. 1 and 2. The loosely-entangled microfibers may be formed from polymeric threads such as aramid threads, polyester threads, synthetic threads, Kevlar® (aramid fibers), Twaron® (aramid fibers), Dyneema® (ultra high resistance polyethylene fibers), Roving® (thread fibers), and mixtures thereof. The threads and fibers employed in this invention are preferably high tensile fibers, threads, yarns, etc.

The fibers, microfibers or threads are treated for maintaining the longitudinal continuity of the fibers into each thread, that is, the fibers of a thread are spaced apart or separated by employing the method of U.S. 10/265,851, thus maintaining such fibers continuous into the thread in order to guarantee the thread continuity, resistance and strength, particularly the tensile strength. The fibers are entangled all together to form a mass comprising loosely-entangled fibers.

The term "entangling" must be understood in this specification as a generic term including the actions of carding, entangling, wrinkling, rumpling, disheveling, etc. which action has the purpose of arranging the threads and fibers aleatory and, even loosely, accommodated into a formless, shapeless, amorphous, body or mass, with the threads and fibers being arranged for preventing any free direct passage being formed through the body, mass or structure. The threads and fibers are most preferably carded and entangled in a manner to form loops, curls, or ringlets. As will be explained in connection to FIG. 9, these curls will be wrapped around the projectile in an easier manner because of the piece, a ring in this embodiment, attached to the projectile after passing through panel 4. This wrapping will occur when the projectile enters the mass of trapping panels 5 with a spinning or rotating movement after shoot from the corresponding weapon. While trapping panel 5 is shown as formed by entangled fibers, this panel may be anyone capable of stopping the bullet or projectile once the projectile has been altered by the attaching of a piece of the ballistic or front panel 4.

For the purposes of the present description, the term "microfiber" must be understood as encircling all kind of fibers, filaments, threads and the like. The prefix "micro" does not refer to the fiber as being very short or

short but is rather employed to refer to thinness of the fibers.

Projectile-trapping panel 5 may be formed into a pack by providing a determined amount of mass of entangled fibers and wrapping the same with an outer cover 16, FIG. 1, which cover may comprise a laminar synthetic material such as a Kevlar (aramid fibers) cloth, etc. Then, the pack may be compacted into a conventional press or any air may be extracted from the pack by means of a vacuum chamber not illustrated because it is a well know technique.

Alternatively, also to form the projectile-trapping panel, the entangled fibers may be wrapped around a core support to form a panel 17 as exemplary shown in FIG. 9. The core support may comprise a plate made, for example, of an elastic material, such as EVA, or any other supporting material. The mass of loosely-entangled fibers may be wrapped around the core support in several directions in order to prevent the formation of interstices through the several layers formed by the plurality of crossed wraps of the entangled threads or fibers.

FIG. 9 shows the sequences of a bullet passing through the several panels and the operation of the assembly of the invention when used for ballistic purposes. As it will be explained in connection to this FIGURE the entangled fiber panels operates adequately as an antitrauma ballistic panel or jacket because the bullet energy is

entirely absorbed before reaching the wearer body and the projectile is retained into the structure. According to the invention the deformable removable pieces, like the ring members and the pieces below disclosed, enhances the trapping effect after the projectile has passed through panel 4 and increased its size, volume and shape.

As it is clearly depicted in FIG. 9, a bullet 18 is approaching a front panel 4 of the inventive assembly with a spinning or rotation movement as indicated by the curved arrows. When penetrating the front panel, the tip of the bullet penetrates at least one ring 7 and this ring is detached and removed from the panel as well as it attaches and remains affixed to bullet 18, as may be seen in the path portion between panels 4 and 5. Then, the bullet with the ring, which are still under rotation, enter into contact with the entangled and/or curled fibers of trapping panel 5. As a result of the rotating movement of the bullet plus the ring outwardly extending from the bullet profile the fibers become more easily wrapped around the bullet/ring and the fibers result completely retained or "adhered" to the bullet/ring. As a result of the bullet-ring combination more fibers are wrapped around the bullet-ring with the ring forming a kind of screw thread that enhances the wrapping of fibers.

As the bullet continues moving ahead and rotating, more fibers wrap around the bullet/ring thus increasing the

bullet size, volume, shape and mass, therefore trapping, stopping and retaining the bullet wrapped in the fibers mass of panel 17 and stopped therein. The bullet and the fibers wrapped around it may form a swelling or bump 21 not transmitted through end panel 6. As may be seen, the bullet energy is entirely absorbed and not transmitted to rear side 3 of the assembly, thus preserving the life of the user of a ballistic jacket and preventing the user from any trauma. As the several tests have shown, the bullet is finally deformed into the entangled mass of fibers and the fibers have found embedded in the bullet metal.

Finally, FIG. 10 shows an alternative ring member 20 comprising a spring coil having the shape of a sand clock and designed to receive the impact of bullets having a piercing tip PB. While the tip of the bullet is sharp to easily perforate any member, the tip is blocked when trapped in the narrow or tight portion 22 of the spring ring 20. A plurality of springs 20 may be arranged in like manner as it is illustrated in the remaining FIGURES, for any of the other ring members, 8, 9, 12, 13, 19, etc.

According to the invention front panel or ballistic panel 4 may comprise a plurality of any kind of pieces, preferably deformable pieces, that are arranged side-by-side and detachably retained into the panel, in one or more layers or planes, in a manner that a piece impinged by a projectile becomes attached to the projectile and removed

from the panel, with such pieces comprising pieces of metal, fabric sheets, compacted and dense ballistic units formed by fibers, and the like. In any case the pieces should be removed from the ballistic panel to be attached to the bullet in order to increase the size, volume and shape of the projectile whereby the projectile with the piece or pieces attached thereto is more easily stopped by any further panel provided for stopping the projectile, such as one or more panels 5.

According to the embodiment shown in FIG. 12, the ballistic panel, herein indicated by number reference 23, comprises a plurality of pieces consisting of compact ballistic units 24 that are arranged into a side-by-side pattern and compacted into dense panel 23, wherein each ballistic unit comprises a plurality of fibers arranged into a bundle that is folded and entangled into a compact mass of fibers, with the fibers being preferably folded and entangled into a knot. Alternatively, ballistic units may be formed by a body of compacted body of fibers 25 as shown in FIG. 14 that may be obtained by compacting the mass or bundle of fibers or by extracting any air from the fibers in a vacuum chamber. The fibers may be arranged within any kind of cover not illustrated. Preferably, the fibers of the ballistic units are made of polymeric threads such as aramid threads, polyester threads, synthetic threads, Kevlar® (aramid fibers), Twaron® (aramid fibers), Dyneema®

(ultra high resistance polyethylene fibers), Roving® (thread fibers), and mixtures thereof.

As it is shown in FIG. 13, as bullet 18 impinges panel 23 it does it through one or more units 24 in such a manner that unit 24 impinged by the bullet is removed from the panel and the unit attaches to the bullet under the action of the high energy, heat generated by the bullet and deformation of the bullet. This attachment increases the size, volume and shape parameters of the bullet and, therefore, the bullet is more easily trapped into the mass or against the surface of any further ballistic panel, such as the panels of FIGS. 1 and 9.

According to even another embodiment of the invention, the ballistic panel, indicated by number reference 26 in FIG. 15, comprises one or more sheets of any material, such as fabric, plastics, metal, etc. capable of being deformed and attached to the impinging bullet. Preferably, sheet 27 comprises a high-tensile strength fabric sheet that is cut into a plurality of pieces 28. More preferably, the panel consists of a plurality of fabric sheets arranged into a pattern in that pieces 28 of one fabric sheet are offset relative the pieces of any adjacent fabric sheet. The high-tensile strength fabric may be made of polymeric threads such as aramid threads, polyester threads, synthetic threads, Kevlar® (aramid fibers), Twaron® (aramid fibers), Dyneema® (ultra high

resistance polyethylene fibers), Roving® (thread fibers), and mixtures thereof. The fabric sheets may be attached into a panel by any appropriate means, adhesives and the like, the fabrics may be compacted or subject to vacuum to form the panel.

FIG. 16 shows a cross-sectional view of panel 26 of FIG. 26 with only one fabric sheet for clarity purposes but is clear that a plurality of sheets may be arranged as shown in FIG. 15. As it is clearly illustrated in FIG. 16 as bullet 18 impinges panel 26 it does it through one or more pieces 28 in such a manner that piece 28 impinged by the bullet is removed from the panel and the piece attaches to the bullet under the action of the high energy from the bullet, heat generated by the bullet and a light deformation of the bullet. This attachment increases the size, volume and shape parameters of the bullet and, therefore, the bullet is more easily trapped into the mass or against the surface of any further ballistic panel, such as the panels of FIGS. 1 and 9.

The ballistic panel of the invention may be combined into any desired assembly pattern with other panels, such as fiber-made panels, etc. with the embodiments shown in FIGS. 1, 9 being only two of a several arrangements that are possible to be constructed with the inventive panel. Generally, the invention provides a ballistic armored assembly comprising at least one

ballistic panel comprising a plurality of side-by-side deformable pieces that are detachably retained into the panel in a manner that a piece impinged by a projectile is removed from the panel and attached to the projectile, whereby the size and shape of the projectile is increased by the attachment of the piece; and at least one projectile-stopping panel, or trapping panel, preferably comprised of a compacted mass of loosely-entangled fibers, whereby the projectile having said increased size and shape is more easily stopped by the projectile-stopping or trapping panel. Projectile-stopping panel, however may be made of any other material appropriate for stopping the bullet. As above already disclosed, the assembly has a front side and a rear side and the at least one ballistic panel is located at least at the front side for receiving the impinging projectile and the at least one projectile-stopping panel is located at least at the rear side for stopping the projectile having the increased size and shape after passing through the ballistic panel.

Preferably, the panels according to the invention form a pack with the panels attached to each other, with least one impact cushioning panel made of EVA being provided at the rear side.

Another alternative assembly illustrated in FIGS. 17, 18, comprises a ballistic panel 29 made according to the teachings of the invention, namely one or more panels

23, 26 or any other panel comprising the ring members of the invention. Panel 29 is covered at both sides thereof by projectile-trapping panels 30, FIG. 29, or may be encapsulated by an integral panel 31, FIG. 18, which panels may be formed by an entangled mass of fibers 32 that may be selected from aramid threads, polyester threads, synthetic threads, Kevlar® (aramid fibers), Twaron® (aramid fibers), Dyneema® (ultra high resistance polyethylene fibers), Roving® (thread fibers), and mixtures thereof. Alternatively, the fibers of the projectile-trapping panels may be wrapped around a core support to form said at least one projectile-trapping panel or may be confined into an outer cover 33. Panels 30, 31 may be compacted in a press or the air in the mass of entangled fibers may be extracted by means of a vacuum.

While preferred embodiments of the present invention have been illustrated and described, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the scope of the invention as defined in the appended claims.